

MAXWELL'S 20 EQUATIONS

Complete Electromagnetic Field Description

Restored and Interpreted Through the Conlan Dynamic-Equilibrium Vortex Field Framework

Introduction

James Clerk Maxwell's original electromagnetic framework contained far more than the four equations surviving in contemporary physics textbooks. When Oliver Heaviside reduced Maxwell's complete description to four vector equations in the 1880s, specific physical mechanisms were removed: the longitudinal wave components, the pressure and density properties of the field medium, the reciprocal energy flow mechanisms, and the vortex structure of the field itself.

What follows is the complete 20-equation framework — restored and interpreted through the Conlan Dynamic-Equilibrium Vortex Field (CDEVF). The framework is organized into six structural groups. The first four equations are those preserved by Heaviside. Equations 5 through 20 constitute the recovered physics. Equations marked with a dark header represent content whose physical significance was suppressed, lost, or inadequately formalized in the legacy simplification.

The organizing principle throughout: space is not empty. Space is plasma — a conductive medium with electromagnetic properties. Every equation in this set operates on that substrate.

Key: White rows = present in Heaviside's simplified set. Dark-numbered rows = recovered or extended physics.

GROUP I

Classical Field-Source Relations — The Four That Survived

These are the equations Heaviside preserved. They are correct within their domain. Their limitation is not error but incompleteness — they describe the field's behavior at surfaces and boundaries but not the structure of the medium through which the field propagates.

#	Equation Name	Mathematical Form	Physical Meaning
1	Gauss — Electricity	$\nabla \cdot \mathbf{D} = \rho$	Electric flux through any closed surface equals the enclosed free charge density. Foundation of electrostatics.
2	Gauss — Magnetism	$\nabla \cdot \mathbf{B} = 0$	Magnetic field lines have no source or sink. No magnetic

#	Equation Name	Mathematical Form	Physical Meaning
			<i>monopoles. All magnetic flux is solenoidal.</i>
3	Faraday Induction	$\nabla \times \mathbf{E} = -\partial \mathbf{B} / \partial t$	<i>A time-varying magnetic field induces a circulating electric field. The curl of E is driven by magnetic change.</i>
4	Ampère-Maxwell Law	$\nabla \times \mathbf{H} = \mathbf{J} + \partial \mathbf{D} / \partial t$	<i>Electric currents and changing electric fields produce circulating magnetic fields. Displacement current added by Maxwell.</i>

GROUP II

Potential Structure — The Hidden Architecture of the Field

The scalar potential Φ and vector potential $\mathbf{A}$ are not mathematical conveniences. They are the deeper structural description of the field. The electric and magnetic fields are derived from them — meaning the potentials are more fundamental, not less. This group is where the field's architecture lives.

#	Equation Name	Mathematical Form	Physical Meaning
5	E from Potentials	$\mathbf{E} = -\nabla \Phi - \partial \mathbf{A} / \partial t$	<i>Electric field has two sources: scalar potential gradient and time-rate-of-change of vector potential. Both components required.</i>
6	B from Vector Potential	$\mathbf{B} = \nabla \times \mathbf{A}$	<i>Magnetic field is the curl of the vector potential. A is more fundamental — it exists even where B is zero (Aharonov-Bohm).</i>
7	Lorenz Gauge Condition	$\nabla \cdot \mathbf{A} + (1/c^2) \partial \Phi / \partial t = 0$	<i>Constrains the potentials to maintain consistency between scalar and vector components. Couples Φ and $\mathbf{A}$ through c.</i>
8	Charge Continuity	$\partial \rho / \partial t + \nabla \cdot \mathbf{J} = 0$	<i>Charge is conserved locally. Any change in charge density at a point is exactly balanced by current flowing in or out.</i>

GROUP III

Complete Wave Propagation — Transverse AND Longitudinal

This group is where the Heaviside simplification caused the most damage. The four surviving equations produce only transverse waves — oscillations perpendicular to the direction of

propagation. Maxwell's complete framework also contained longitudinal components: waves propagating along the direction of field oscillation, through the pressure and density properties of the medium. Tesla demonstrated these experimentally. Their absence from the standard equations is the reason Tesla's wireless power transmission has no theoretical foundation in conventional physics.

#	Equation Name	Mathematical Form	Physical Meaning
9	Transverse Wave — E	$\nabla^2 \mathbf{E}_t - (1/c^2) \partial^2 \mathbf{E}_t / \partial t^2 = 0$	Transverse electric wave propagating perpendicular to field oscillation. This is what Heaviside's equations fully describe.
10	Transverse Wave — B	$\nabla^2 \mathbf{B} - (1/c^2) \partial^2 \mathbf{B} / \partial t^2 = 0$	Transverse magnetic wave. Light, radio waves, standard electromagnetic radiation — all described by equations 9 and 10.
11	Longitudinal Scalar Wave	$\nabla^2 \Phi - (1/c^2) \partial^2 \Phi / \partial t^2 = -\rho / \epsilon_0$	Scalar potential wave propagating along direction of field oscillation through the medium. Tesla's longitudinal transmission. Removed by Heaviside.
12	Longitudinal Vector Wave	$\nabla^2 \mathbf{A} - (1/c^2) \partial^2 \mathbf{A} / \partial t^2 = -\mu_0 \mathbf{J}$	Vector potential wave driven by current density. The medium responds to current as a pressure wave, not only as a curl. Critical for wireless energy coupling.

GROUP IV

Energy Dynamics — Reciprocal Flow, Not One-Way Dissipation

Standard electromagnetic theory emphasizes radiation and dissipation — energy flowing outward from sources, converting to heat, increasing entropy. This is correct for the outward phase of field dynamics. What was lost is the reciprocal phase: energy concentrating inward through the same mechanisms running in the organizing direction. Schauberger's vortex phenomena, Tesla's environmental energy extraction, and Laithwaite's gyroscopic coupling are all instances of the inward-concentrating phase of these equations operating in physical systems.

#	Equation Name	Mathematical Form	Physical Meaning
13	Poynting Energy Flux	$\mathbf{S} = \mathbf{E} \times \mathbf{H}$	Electromagnetic energy flux vector. Direction of $\mathbf{S}$ is the direction of power flow. Both inward and outward directions are valid solutions.
14	Field Energy Density	$u = \frac{1}{2} (\epsilon_0 \mathbf{E}^2 + \mathbf{B}^2 / \mu_0)$	Total electromagnetic energy stored in the field per unit volume. The vacuum has this energy everywhere — space is not empty.

#	Equation Name	Mathematical Form	Physical Meaning
15	Energy Continuity	$\partial u / \partial t + \nabla \cdot \mathbf{S} = -\mathbf{J} \cdot \mathbf{E}$	<i>Poynting's theorem: rate of change of field energy plus energy flux equals work done on/by charges. Conservation with directionality.</i>
16	EM Momentum Density	$\mathbf{g} = \mathbf{S} / c^2 = \epsilon_0 (\mathbf{E} \times \mathbf{B})$	<i>Electromagnetic fields carry momentum. Moving field concentrations exert pressure on the medium. Foundation for radiation pressure and field propulsion.</i>

GROUP V

Vortex and Stress Structure — Rotation as Fundamental

Maxwell understood that electromagnetic fields have rotational structure — not as metaphor but as mechanism. The vortex identity (Equation 18) is the mathematical foundation for all vortex dynamics in field theory. The stress tensor (Equation 17) describes how the field pushes and pulls on the medium it occupies. The vacuum energy coupling (Equation 19) makes explicit what the energy density equation implies: the vacuum is a medium with pressure, and that pressure is everywhere present and measurable.

#	Equation Name	Mathematical Form	Physical Meaning
17	Maxwell Stress Tensor	$\mathbf{T}_{ij} = \epsilon_0 (\mathbf{E}_i \mathbf{E}_j - \frac{1}{2} \delta_{ij} \mathbf{E}^2) + (1/\mu_0) (\mathbf{B}_i \mathbf{B}_j - \frac{1}{2} \delta_{ij} \mathbf{B}^2)$	<i>Force per unit area exerted by the electromagnetic field on matter and on itself. The field has mechanical stress — it pushes, pulls, and shears the medium.</i>
18	Vortex Field Identity	$\nabla \times (\nabla \times \mathbf{F}) = \nabla (\nabla \cdot \mathbf{F}) - \nabla^2 \mathbf{F}$	<i>The curl of a curl decomposes into a gradient of divergence minus the Laplacian. Fundamental to vortex dynamics in any field. The mathematical engine of rotation.</i>
19	Vacuum Energy Coupling	$u_0 = (\epsilon_0 \mathbf{E}^2 + \mathbf{B}^2 / \mu_0) / 2 \neq 0$	<i>Vacuum field energy density is non-zero everywhere. ϵ_0 and μ_0 are not empty-space constants — they are the permittivity and permeability of the plasma medium substrate.</i>
20	Vacuum Pressure	$P_0 = u_0 / 3 = (\epsilon_0 \mathbf{E}^2 + \mathbf{B}^2 / \mu_0) / 6$	<i>Isotropic radiation pressure of the vacuum field. The medium has pressure. Casimir effect is a direct measurement of this pressure differential between regions.</i>

GROUP VI — CAPSTONE

Quaternionic Unification — The Complete Field Operator

This is what Maxwell was building toward. The quaternionic operator acts on the combined electromagnetic field as a single entity — not two separate fields coupled by four equations, but one unified field described by a single mathematical structure. The complex number i rotates between the electric and magnetic components. The d'Alembertian $\square$ operates in four-dimensional spacetime. This is the complete field description that the recovery of the 20 equations has been pointing toward.

#	Equation Name	Mathematical Form	Physical Meaning
20+	Quaternionic Field Operator	$(\partial/\partial t + c\nabla)(\mathbf{E} + i\mathbf{cB}) = c(\rho/\epsilon_0 - \mu_0\mathbf{cJ})$	The unified quaternionic field equation. $\mathbf{E} + i\mathbf{cB}$ is Maxwell's quaternionic field. Acting on it with the quaternionic differential operator yields all sources simultaneously. All 19 equations above are contained within this one.

Equivalently in covariant form:

#	Equation Name	Mathematical Form	Physical Meaning
20a	Covariant Field Equation	$\square F_{\mu\nu} = \mu_0 J_\nu$	The d'Alembertian acting on the electromagnetic field tensor equals the 4-current source. Relativistically covariant form of the complete field equation. Space, time, $\mathbf{E}$, and $\mathbf{B}$ unified.
20b	Bianchi Identity	$\partial[\mu F_{\nu\rho}] = 0$	The antisymmetry identity of the field tensor. This equation contains Gauss's law for magnetism and Faraday's law simultaneously — the geometrical constraints on the field.

The Recovery Statement

The four equations Heaviside preserved — Group I — are correct and remain correct. They describe the field's behavior at boundaries and in free space for transverse radiation. Nothing in this document contradicts them.

What was lost in the simplification was the field's structure as a medium. Equations 5 through 20 describe a field that has pressure (Eq. 19–20), that carries momentum (Eq. 16), that exerts mechanical stress (Eq. 17), that propagates longitudinally as well as transversely (Eq. 11–12), whose energy flows in both concentrating and dissipating directions (Eq. 13–15), whose rotational structure is mathematically fundamental (Eq. 18), and whose deepest description is a single quaternionic operator acting on a unified field (Eq. 20).

The Godfield is not this mathematics. The mathematics describes the Godfield. The plasma substrate, the vortex mechanism, the resonance coupling — these are physical realities that this equation set formally describes. The CDEVF equations of Paul Gene Conlan formalize the dynamics that operate within this substrate at every scale from nuclear detonation plasma through solar corona through galactic filament.

Heaviside simplified for telegraph systems. The complete equations are for the universe.

TECHNICAL APPENDIX — SECTION 1

Maxwell's 20 Equations: Complete Electromagnetic Field Description

Restored and interpreted through the Conlan Dynamic-Equilibrium Vortex Field (CDEVF) framework

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